Metals have been around a long time. For most of history, processing of metals has fallen neatly into methods involving melting/casting of alloys and/or working/shaping the metal once formed. The properties of metals always depend on their microstructure – the way crystalline grains or phases, and defects within them, are distributed through the material at small scales. Common microstructures include grains, precipitates, eutectic lamellae, and dendrites. This list is pretty limited, and as a result we tend to think the spectrum of microstructural morphologies has been exhaustively studied. My group’s work shows this is not true!

Over the past decades, using a process called dealloying, we have made a variety of novel microstructures in bulk materials. Dealloying refers to the selective dissolution of one element from a multi-component alloy, allowing production of nanoporous metals, such as nanoporous gold leaf foils we have used for catalytic applications (and similar to processing done in pre-Columbian metalwork). If such dissolution is done in molten metals (e.g., dissolving Ti from Ti-Ta alloys in molten copper), we can make dense two-phase metal-metal nanocomposites with excellent mechanical properties due to their new microstructure. Excavating one phase from these materials yields strangely organic particles whose internal porosity is quite beautiful (see Figure). This kind of microstructure will be central to materials development for 3-D printing (additive manufacturing), expanding the applications and performance of future metals. The presentation will discuss the production, structure, and properties of these novel nanocomposites.